DOCUMENT RESUME

ED 067 265 SE 014 715

AUTHOR Pace, Angela
TITLE Conservation of Identity and Equivalence Among Children from Varying Socio-Economic Backgrounds.
PUB DATE [72]
NOTE 19p.

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS *Conservation (Concept); *Elementary School Mathematics; Grade 1; Grade 2; Kindergarten; Learning; *Mathematics Education; *Number Concepts; *Socioeconomic Influences; Student Characteristics

ABSTRACT

This study investigates the relationship of socio-economic status to the acquisition of two basic ideas underlying the concept of number conservation, "conservation of identity" and "conservation of equivalence." Tests for conservation of identity and of equivalence, detailed in the paper, were given to kindergarten, first, and second grade children from low-income and middle-class backgrounds. The study found a greater proportion of the middle-class children conserving equivalence, with significant differences at the first and second grade levels. On the conservation of identity test, the two socio-economic groups differed significantly at the kindergarten level. Results also indicated that the identity tasks were significantly easier than the equivalence tasks for children in both socio-economic groups. (Author/DT)

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY

ED 067265

CONSERVATION OF IDENTITY AND EQUIVALENCE AMONG CHILDREN FROM VARYING SOCIO-ECONOMIC BACKGROUNDS

ABSTRACT

The major concern of this study was the relationship of socio-economic status to the acquisition of two basic ideas underlying the concept of number -- "conservation of identity" and "conservation of equivalence". The Conservation of Equivalence Test given to kindergartners, first and second graders from low-income backgrounds and from middle-class homes revealed a greater proportion of conservers among the middle-class children, with significant differences between the first grades and between the second grades. On the Conservation of Identity Test, the two socio-economic groups differed significantly at the kindergarten level. Results also indicated that the identity tasks were significantly easier than the equivalence tasks for children in both socio-economic groups.

SE 014 715

CONSERVATION OF IDENTITY AND EQUIVALENCE AMONG CHILDREN FROM VARYING SOCIO-ECONOMIC BACKGROUNDS[1]

Angela Pace

Numerous investigations, beginning with the classic experiments of Piaget (1952), have been conducted for the purpose of assessing number conservation among young children. While many of these studies were concerned with corroborating Piaget's findings or with training techniques for inducing conservation, only a few, by researchers like Hyde (1959), Slater (1964), Brace and Nelson (1965), and Almy (1966), were concerned wholly, or in part, with the effect of socio-economic status upon acquisition of the concept. Even fewer studies have been concerned with the two basic ideas underlying the concept of number conservation that (1)the number of a given set remains unchanged despite rearrangement of its elements and (2) once two sets have been placed in one-to-one correspondence, changes in the arrangement of the members of one set or the other in no way affects either the equivalency relation or the cardinal number of each of the equivalent sets. Elkind (1967) referred to the above two ideas as "conservation of identity" and "conservation of equivalence" respectively. In a study investigating the developmental sequence of the two concepts, Hooper (1969) concluded that identity conservation appeared to precede equivalence conservation.

To the author's knowledge, there have been no studies which have explored differences among children from low-income and middle-class backgrounds with regard to acquisition of conservation of identity and conservation of equivalence, nor have there been studies to determine which of the two concepts appears to be easier or more difficult for children from varying socio-economic levels to acquire.

PURPOSE OF THE STUDY

The major concern of this study was the relationship of socio-economic status to the acquisition of the concept of number conservation. The specific objectives were as follows:

(1) To determine if there are important differences in mean CA's and mean IQ's (a) between conservers and nonconservers from low-income backgrounds and (b) between conservers and nonconservers from middle-class backgrounds.

(2) To determine if there are significant differences between the two socio-economic groups in the number of conservers on tasks involving conservation of equivalence and on tasks involving conservation of identity.

(3) To determine whether tasks involving conservation of identity are significantly easier or more difficult than tasks involving conservation of equivalence.

METHOD

Subjects

Children selected for this study attended kindergarten, first-grade and second-grade classes in the eight public schools of a city in central New York State. Three of the schools had enrollments of children predominately from low-income backgrounds. The children in these schools were arranged alphabetically according to sex within each of the three grade levels and then, with the aid of Kendall and Smith's Table of Random Numbers, a random sample of one hundred at each level, with approximately the same number of girls as boys, was drawn.

The remaining five schools had enrollments of predominately middle-class children. A random sample of one hundred middle-class children at each of the three grade levels was drawn from these five schools, using the same procedure as that followed in obtaining the sample of children from low-income homes.

Lists of the children who had been randomly selected from the two socio-economic backgrounds were then presented for final screening by the eight building principals and the teachers in kindergarten, grade one, and grade two. At this time, the name of any child who did not belong on the list of those from low-income backgrounds or on the list of those from middle-class backgrounds was deleted.

The final sample included 573 children distributed as follows:

	Low-Income			Middle-Class		
	Boys	Girls	Total	Boys	Girls	Total
Kdg	50	45	95	5I	5I	I02
Gr. I	45	45	90	48	5I	99
Gr. 2	45	44	89	48	50	98
		Total	274		Total	299

The children from low-income backgrounds came from families where the wage earners were semiskilled workers, unskilled workers, unemployed, or on relief. Over 75 per cent of these children came from families whose yearly income was less than $4500, with 24 per cent of the children from families on welfare. The middle-class children came from families where 44 per cent of the fathers were engaged in professional, technical or managerial work; 2I per cent, in business and skilled occupations; 18 per cent in semiskilled work; and the rest, in clerical or service work.

Administration of tests

In a period of thirty days, ending on May 5th, three tests were administered. These were: (I) The Lorge-Thorndike Tests, Level I Form A for Kindergarten-Grade I, or Level 2 Form A for Grades 2-3, (2) Test I on Conservation of Equivalence and (3) Test II on Conservation of Identity. Tests I and II were administered individually outside the classrooms by the experimenter and all testing sessions were recorded on tape. In this way, responses to the test items would be available for use by raters in their categorization of children as conservers or nonconservers.

Description of Test I and Test II

Test I consisted of three tasks — Tasks A, B, C — designed to test acquisition of the concept of conservation of equivalence. Task A was concerned with the problem of correspondence between sets objects that were heterogeneous but qualitatively complementary. Tasks B and C were concerned with correspondence between sets of objects similar except for color. Test II consisted of two tasks — Tasks D and E — both concerned with identical sets and designed to test acquisition of the concept of conservation of identity.

Test I Conservation of Equivalence

Task A

Materials: A box containing 12 plastic teaspoons
A set of 6 cups

Procedure: The examiner will place 6 cups side by side as close together as possible in front of the child. The child will be asked to get just as many spoons as there are cups and to place these in a row below the set of cups. Question I will be asked. If this part is completed successfully, the examiner will continue by placing the spoons in a stack. Question 2 will be asked.

Questions:

No.I Are there just as many spoons as there are cups?

No.2 Are there just as many spoons as there are cups now?
If the answer to this is positive, the child will be asked, "How can you tell?"
If the answer is negative, the child will be asked, "Are there more spoons or more cups?" and "How can you tell?"

Task B

Materials: A box containing 15 red checkers
A set of 7 black checkers

Procedure: The examiner will place 7 black checkers in a row an inch apart. The child will be asked to get just as many red checkers as there are black checkers and to place them in a row below the black checkers. Question 3 will be asked. If this part is completed successfully, the red checkers will be spread apart as shown below.

Question 4 will be asked.

Questions:

No. 3 Are there just as many red checkers as there are black ones?

No. 4 Are there just as many red checkers as there are black ones now?

If the answer is positive, the child will be asked, "How can you tell?"

If the answer is negative, the child will be asked, "Are there more black checkers or more red ones?" and "How can you tell?"

Task C

Materials: A box containing 15 red checkers
A set of 8 black checkers

Procedure: After placing the 8 black checkers in a row, the examiner will ask the child to get as many red checkers as there are black ones. Question 3, used in Task B also, will be asked. If this part is completed successfully, the red checkers will be pushed together so they will appear as follows:

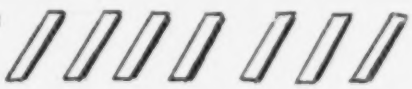
Question 4, used in Task B also, will be asked.

Test II Conservation of Identity

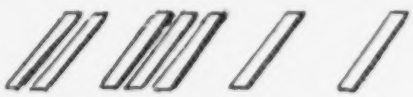
Task D

Materials: 7 sticks, each measuring 6" x 1" x $\frac{1}{4}$".

Procedure: The examiner will place 7 evenly spaced sticks in a row thus:



The child will be asked to count the sticks in the set. Then the examiner will rearrange the sticks into 4 subsets as follows:



Questions 5 and 6 will be asked.

Questions:

No. 5 How many sticks are there now?

No. 6 How do you know?

Task E

Materials: 8 sticks of the same size as those used in Task D.

Procedure: As in Task D, the sticks will be placed in a row and the child will be asked to count the sticks in the set. Then the sticks will be rearranged into 4 subsets as follows:

Questions 5 and 6, also used in Task D, will be asked.

Scoring of Test I and Test II

Depending upon their responses, the children were classified as conservers or nonconservers on each of the three tasks of Test I. Tasks A, B, and C each required the child to make a set equivalent to the experimenter's set and then to assert equivalence upon the rearrangement of one of the sets. Children who made errors in the one-to-one matching were placed at Stage I. Children placed at Stage II included those who, subsequent to the successful completion of the one-to-one correspondence, either failed to assert equivalence once the arrangement of elements within one set had been altered, or else responded that the two sets had the same quantity but were un-

able to justify their response with an adequate explanation. Stage 3 included those children whose recognition of equivalence of the two sets was accompanied by clear explanations indicating an understanding of number conservation. Children at Stages 1 and 2 were then classified as nonconservers and those at Stage 3 as conservers.

The children were also classified as conservers or nonconservers on Tasks D and E of Test II. Each of these two tasks was concerned with a single set of objects. In each case, the child was first required to count the objects in the set. Following the rearrangement of the objects, he was then asked to indicate the number of the set again. If he was able to do this immediately without resorting to a recount, he was classified as a conserver. Otherwise he was categorized as a nonconserver.

Classification of the children on the five tasks was completed by three judges. There was 98 per cent agreement on the categorizations.

RESULTS

First, an analysis of the data was made to determine if there were significant differences in chronological ages and intelligence quotients at each of the three grade levels between (a) the conservers and the nonconservers from low-income backgrounds and (b) the conservers and nonconservers from middle-class homes. Point biserial correlations were calculated, with the statistic $t = r_{pbi}\sqrt{\frac{N-2}{1 - r^2_{pbi}}}$ used to test their significance. Results regarding t's and significance levels are presented in Tables 1, 2, 3, and 4.

Table 1. Comparison of Chronological Ages of Conservers and Nonconservers from Low-Income Backgrounds on Test I and Test II

	Mean Chronological Ages		
Test I Task A	Conservers	Nonconservers	t_r
Kdg.	69.7	68.3	1.06
Gr. 1	84.2	82.4	1.23
Gr. 2	97.8	98.4	-.42
Test I Task B			
Kdg.	72.2	68.4	2.78**
Gr. 1	84.6	82.4	1.35
Gr. 2	99.2	97.8	.881
Test I Task C			
Kdg.	71.3	68.3	2.00*
Gr. 1	84.4	82.0	2.05*
Gr. 2	98.7	97.7	.704
Test II Task D			
Kdg.	71.7	68.2	2.67**
Gr. 1	82.8	82.5	.257
Gr. 2	97.8	98.6	- .514
Test II Task E			
Kdg.	66.6	68.7	- 1.4[illegible]
Gr. 1	82.8	82.5	.343
Gr. 2	98.4	97.9	.312

* Significant at .05
**Significant at .01

In general, the conservers from low-income homes tended to be slightly older than the nonconservers. Table 1 shows a limited number of significant differences, with most of these at the kindergarten level.

Table 2. Comparison of Chronological Ages of Conservers and Nonconservers from Middle-Class Backgrounds on Test I and Test II

	Mean Chronological Ages		
	Conservers	Nonconservers	t_r
Test I Task A			
Kdg.	70.2	68.7	1.49
Gr. 1	81.5	81.6	- .115
Gr. 2	93.7	93.9	-.213
Test I Task B			
Kdg.	69.2	68.9	.331
Gr. 1	82.7	81.1	1.721
Gr. 2	93.5	94.0	- .481
Test I Task C			
Kdg.	68.8	68.9	- .168
Gr. 1	82.2	81.0	1.428
Gr. 2	93.3	94.5	- 1.237
Test II Task D			
Kdg.	69.0	68.9	.061
Gr. 1	82.2	80.8	1.570
Gr. 2	94.2	93.5	.781
Test II Task E			
Kdg.	68.5	69.0	- . 553
Gr. 1	81.8	80.9	1.038
Gr. 2	93.7	93.9	- .227

Table 2 reveals no significant differences between the mean chronological ages of the conservers and the nonconservers from middle-class backgrounds.

Table 3. Comparison of Mean IQ's of Conservers and Nonconservers from Low-Income Backgrounds on Test I and Test II

	Mean IQ's		
	Conservers	Nonconservers	t_r
Test I Task A			
Kdg.	102.7	96.6	1.611
Gr. 1	99.2	96.1	.962
Gr. 2	90.3	89.9	.085
Total	94.6	94.7	- .090
Test I Task B			
Kdg.	111.2	96.6	2.95**
Gr. 1	98.8	96.2	.745
Gr. 2	89.2	90.4	- .551
Total	94.0	94.8	- .390
Test I Task C			
Kdg.	108.0	96.3	2.66**
Gr. 1	99.0	95.6	1.39
Gr. 2	89.5	90.5	- .522
Total	94.5	94.7	—
Test II Task D			
Kdg.	106.4	96.2	2.602**
Gr. 1	97.8	95.5	1.130
Gr. 2	88.9	91.4	-1.25
Total	94.4	94.8	—
Test II Task E			
Kdg.	102.3	96.8	1.215
Gr. 1	91.2	101.6	-5.540**
Gr. 2	88.1	92.7	-2.32*
Total	90.4	97.2	-5.17**

Table 3 reveals that only in the kindergarten, and for three of the five tasks, were the mean IQ's of the conservers from low-income homes significantly greater than those of the nonconservers. When the results for the kindergarten, first and second grades were com-

bined for a particular task, the mean IQ's of the conservers were not significantly greater than those of the nonconservers from this socio-economic level.

Table 4. Comparison of Mean IQ's of Conservers and Nonconservers from Middle-Class Backgrounds on Test I and Test II

	Mean IQ's		
	Conservers	Nonconservers	t_r
Test I Task A			
Kdg.	102.6	103.1	- .151
Gr. 1	111.1	104.9	2.417*
Gr. 2	110.3	105.9	2.00*
Total	109.3	104.4	3.42**
Test I Task B			
Kdg.	104.2	102.9	.396
Gr. 1	109.9	105.4	1.692
Gr. 2	110.7	105.7	2.315*
Total	109.4	104.4	3.47**
Test I Task C			
Kdg.	107.0	102.3	1.584
Gr. 1	110.0	103.9	2.543*
Gr. 2	109.8	104.8	2.27*
Total	109.5	103.3	4.77**
Test II Task D			
Kdg.	108.9	101.3	3.129**
Gr. 1	107.1	106.3	.315
Gr. 2	107.9	107.5	.162
Total	107.8	104.4	2.51*
Test II Task E			
Kdg.	108.8	101.9	2.45*
Gr. 1	107.2	106.2	.401
Gr. 2	109.7	105.3	2.027*
Total	108.5	103.9	3.51**

Table 4 shows that, with respect to the middle-class children, the mean IQ's of the conservers on a number of tasks were significantly greater than those of the nonconservers. Furthermore, when the results for the three grades were combined for a particular task, the mean IQ's of the conservers on all five tasks were significantly greater than those of the nonconservers.

Next, an analysis of the data was made to determine if there were significant differences between the proportion of conservers in the low-income groups and the proportion of conservers in the middle-class groups on Tasks A, B, C of Test I and on Tasks D, E of Test II. Tables 5 and 6 present comparisons of kindergarten, first- and second-grade children from the two socio-economic levels with respect to (a) the proportion of conservers on Test I(Tasks A, B, C), and (b) the proportion of conservers on Test II(Tasks D, E). The z statistic for testing significance of differences between proportions was used.

Table 5. Comparison of Low-Income and Middle-Class Groups on Three Conservation of Equivalence Tasks (Tasks A, B, C of Test I)

		Proportion of Conservers			
Test I		Middle-Class	Low-Income	z	Significance
Task A	Kdg.	.137	.105	.681	ns
Task B	Kdg.	.117	.042	1.923	$p < .10$
Task C	Kdg.	.157	.074	1.804	$p < .10$
Task A	Gr. 1	.303	.133	4.47**	$p < .01$
Task B	Gr. 1	.303	.111	3.23**	$p < .01$
Task C	Gr. 1	.465	.266	2.83**	$p < .01$
Task A	Gr. 2	.408	.359	.688	ns
Task B	Gr. 2	.408	.269	2.00*	$p < .05$
Task C	Gr. 2	.592	.449	1.96*	$p < .05$

Table 5 indicates a greater proportion of conservers among the middle-class children, at each of the grade levels, than among the children from low-income homes on all the tasks of Test I, with significantly greater proportions in five of the nine comparisons. This table also shows that there were surprisingly large proportions of children from both socio-economic backgrounds who had not yet acquired the concept of conservation of equivalence even near the end of grades one and two.

Table 6. Comparison of Low-Income and Middle-Class Groups on Two Conservation of Identity Tasks (Tasks D, E of Test II)

		Proportion of Conservers			
Test II		Middle-Class	Low-Income	z	Significance
Task D	Kdg.	.225	.063	3.24**	$p < .01$
Task E	Kdg.	.157	.074	1.84	ns
Task D	Gr. 1	.535	.455	1.09	ns
Task E	Gr. 1	.535	.488	.64	ns
Task D	Gr. 2	.479	.516	- .505	ns
Task E	Gr. 2	.541	.573	- .444	ns

Table 6 shows that, with one exception, there were no significant differences between the proportions of conservers from the two socio-economic levels on the two conservation of identity tasks.

Tables 5 and 6 reveal that the proportion of conservers of on the two conservation of identity tasks was greater in all cases to the proportion of conservers on the three conservation of equivalence tasks. Since this seemed to indicate that Tasks D and E were easier than Tasks A, B, and C, a final comparison between the total number of conservers, at each of the grade levels, on Tasks A, B, and C

and the total number of conservers on Tasks D and E was made in order to determine if Tasks D and E were significantly easier. Results are presented in Table 7.

Table 7. Comparison of Performance on Conservation of Equivalence Tasks and on Conservation of Identity Tasks Among Children from Middle-Class and Low-Income Backgrounds

	Proportion of Conservers on Tasks A,B,C	Proportion of Conservers on Tasks D and E	z	Significance
SES-L* (n=274)	.198	.361	-6.71**	$p < .001$
SES-M (n=299)	.319	.410	-3.59**	$p < .01$
SES-M and SES-L combined	.258	.387	-5.00**	$p < .001$

* SES-L here refers to the entire sample of kindergarten, first- and second-grade children from low-income homes. SES-M refers to the entire sample from middle-class homes.

Table 7 indicates that Tasks D and E were significantly easier than Tasks A, B, and C. Significantly greater proportions of children from low-income homes, from middle-class homes, and from the two socio-economic levels combined were successful on tasks involving conservation of identity than on tasks involving conservation of equivalence.

Summary of results

1. There appeared to be little relation between performance on conservation tasks and chronological age. In general the differences in mean CA's of conservers as compared to the mean CA's of nonconservers from either low-income or middle-class backgrounds were not significant.

2. Some relationship between IQ and performance on the conservation tasks was found. Among the low-income groups, the mean IQ's of the conservers in kindergarten were significantly greater than those of the nonconservers on two conservation of equivalence tasks and on one conservation of identity task. Among the middle-class groups, a number of significant differences were found between the mean IQ's of conservers, at various grade levels and on a number of the tasks, and the mean IQ's of the nonconservers. When the results for the three grade levels were combined for a particular task, it was found that the IQ's of the conservers from middle-class homes were significantly greater than those of the nonconservers on all three of the conservation of equivalence tasks and on both the conservation of identity tasks. This did not hold true for the conservers from low-income homes.

3. The proportion of conservers was greater for the middle-class children than for the children from low-income homes on all three conservation of equivalence tasks of Test I, with significant differences between (a) the first grades on Tasks A, B, and C and (b) the second grades on Tasks B and C.

4. On the conservation of identity tasks of Test II, the proportion of conservers among the kindergartners from middle-class homes was significantly greater on Task D only. In all other instances, however, the proportion of conservers from the two socio-economic levels did not differ significantly on the identity tasks.

5. Tasks D and E involving conservation of identity were significantly easier for the children in both socio-economic groups than Tasks A, B, and C involving conservation of equivalence.

IMPLICATIONS

Of the two basic ideas underlying the concept of number, "conservation of identity" appears to be easier for the young child to grasp than "conservation of equivalence". This may be due to the fact that tasks involving conservation of identity are concerned with one set only, say Set A. In this case, it is necessary for the child to recognize that the number of Set A remains unchanged

when its members are rearranged. If the rearranged set is designated as Set A_r, then the child needs merely to recognize that n(Set A) = n(Set A_r). Conservation of equivalence is apparently a more difficult concept to grasp. The tasks involving conservation of equivalence are concerned with two equivalent sets, say Set A and Set B. The members of Set B are rearranged (B_r) and the child has then to assert the equivalence of Set A and Set B_r. It can be seen that these tasks require that the child have an understanding of conservation of identity and of the transitive property of equivalent sets. With these understandings, the child is enabled to conclude that if n(Set A) = n(Set B) and if n(Set B) = n(Set B_r) since these are identical sets, then n(Set A) = n(B_r).

In conclusion, this study has shown surprisingly large numbers of children from low-income homes, as well as from middle-class homes, who have yet to acquire the concept of number by the end of the first and second grades. This would suggest that teachers ought to make definite efforts to develop the concepts of conservation of identity and equivalence before requiring children to do much in the way of computations in the early grades.

FOOTNOTE

1. This study was supported in part by Grant #23-0073A and also by a Faculty Research Fellowship from The Research Foundation of State University of New York.

REFERENCES

1. Almy, Millie, Chittenden, Edward, and Miller, Paula, Young Children's Thinking: Studies of Some Aspects of Piaget's Theory, Teachers College Press, Teachers College, Columbia University, New York, 1966.

2. Brace, Alec and Nelson, L. Doyal, "The Preschool Child's Concept of Number," The Arithmetic Teacher, 1965, 12, 126-133.

3. Elkind, David, "Piaget's Conservation Problems," Child Development, 1967, 38, 15-27.

4. Hooper, Frank, "Piaget's Conservation Tasks: The Logical and Developmental Priority of Identity Conservation," Journal of Experimental Child Psychology, 1969, 8, 234-249.

5. Hyde, Doris Matilda, "An Investigation of Piaget's Theories of Development of the Concept of Number," Unpublished Ph.D thesis, University of London, 1959.

6. Piaget, Jean, The Child's Conception of Number, London: Routledge and Kegan Paul Ltd., 1952.

7. Slater, C.W., "A Study of the Influence Which Environment Plays in Determining the Rate at Which a Child Attains Piaget's 'Operational' Level in His Early Number Concepts," Reported in Lunzer, E.A., Recent Studies In Britain Based on the Work of Jean Piaget, The National Foundation for Educational Research in England and Wales, Occasional Publication, 1964, No. 4.